

In re Patent Application of  
**STORM ET AL.**  
Serial No. 10/820,463  
Filed: APRIL 8, 2004

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REMARKS

Applicants thank the Examiner for the careful and thorough examination of the present application. Claims 11-38 remain pending in the application. Favorable reconsideration is respectfully requested.

I. The Invention

The present invention (e.g. as set forth in independent Claim 11) is directed to an image sensor including an array of pixels, each pixel comprising a photodiode, a semiconductor device having a capacitance and being connected to the photodiode and operating based upon a sub-threshold for providing a signal that is proportional to a logarithm of light intensity on the photodiode, and a calibration circuit having a capacitance and for applying a voltage having a constant rate of change across the capacitance associated with the semiconductor device and said calibration circuit for producing a constant current within the pixel.

II. The Claims are Patentable

The independent Claims 11, 20 and 30 were rejected as being obvious in view of the Kozlowski et al. reference.

Kozlowski et al. is directed to an ultra-low noise, high gain interface circuit for single-photon readout of known photodetectors from the x-ray to long IR bands at video frame rates. The detector current modulate's a load FET's gate-to-source voltage, which in turn modulates the gate-to-source voltage of a gain FET thereby producing a signal current that is an amplified facsimile of the detector current. The load

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FET's gate-to-source voltage is connected in the negative feedback loop of a low noise, high gain amplifier. This effectively reduces the resistance seen by the photodetector by the gain of the amplifier thereby reducing the interface circuit's RC time constant by the same amount. Because the amplifier pins the load FET's gate voltage for a given flux level, the load FET's 1/f noise is transferred to the amplifier thereby enabling single-photon readout sensitivity.

The Examiner specifically relied upon the differential amplifier in Fig. 6 of the Kozlowski et al. reference as allegedly meeting the claimed feature of a calibration circuit. However, Applicants maintain that the Examiner has mischaracterized the teachings of the reference in an attempt to meet the claimed feature. Indeed, there is nothing in Kozlowski et al. that refers to the differential amplifier as a calibration circuit at all.

As discussed in the background section of the present application, calibration is used in logarithmic imagers since there can be large mismatch in the gate-source voltage of a transistor that is generating the logarithmic voltage. To know or learn the mismatch, the transistor from every pixel in the array needs to be calibrated with the same current. In the circuit disclosed in Kozlowski et al. this is not possible since there is no way of isolating the photodiode from the logarithmic generating transistor. Thus, the photocurrent would corrupt any calibration current.

Furthermore, without any support in the Kozlowski et al. reference or any other cited reference, the Examiner has taken the position that it would have been obvious to use the

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differential amplifier in the image sensor of Kozlowski et al. as a calibration circuit for applying a voltage having a constant rate of change across the capacitance associated with the semiconductor device and for producing a constant current within the pixel. Applicants maintain that the Examiner has engaged in impermissible hindsight reasoning in the hypothetical modification of the Kozlowski et al. reference.

For example, it may be known to use a ramp voltage to generate a current, but the Examiner has not provided any teaching or reasoning that it would have been obvious to use the differential amplifier in the image sensor of Kozlowski et al. as a calibration circuit for applying such a ramp voltage, let alone a voltage having a constant rate of change across the capacitance associated with the semiconductor device and for producing a constant current within the pixel, as claimed. It is Applicants who discovered the advantages of providing such a calibration circuit in an image sensor.

Also, the Kakumoto reference is directed to an image sensor and teaches that switches are turned on to hold an image signal at a negative electrode of a capacitor, then a switch is turned on to hold a noise signal at a positive electrode of a capacitor. A switch is turned on and then a switch is turned on to combine together the image and noise signals thus held and thereby produce, as a voltage signal, a noise-free image signal at the node between the capacitor Cs and the switch MIX. Then a switch is turned on to output the noise-free image signal.

The Kakumoto image sensor also does not include a calibration circuit as claimed. Accordingly, such reference

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cannot make up for the deficiencies of Kozlowski et al. as discussed above. The combination of teachings of the cited references, even if obvious as alleged by the Examiner, cannot result in the invention as claimed.

There is simply no teaching or suggestion in the cited references to provide the combination of features as claimed. Accordingly, for at least the reasons given above, Applicants maintain that the cited references do not disclose or fairly suggests the invention as set forth in Claims 11, 20 and 30. Furthermore, no proper modification of the teachings of these references could result in the invention as claimed. Thus, the rejections under 35 U.S.C. §103(a) should be withdrawn.

It is submitted that the independent claims are patentable over the prior art. In view of the patentability of the independent claims, it is submitted that their dependent claims, which recite yet further distinguishing features are also patentable over the cited references for at least the reasons set forth above. Accordingly, these dependent claims require no further discussion herein.

### III. Conclusion

In view of the foregoing remarks, it is respectfully submitted that the present application is in condition for allowance. An early notice thereof is earnestly solicited. If, after reviewing this Response, there are any remaining informalities which need to be resolved before the application can be passed to issue, the Examiner is invited and

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respectfully requested to contact the undersigned by telephone  
to resolve such informalities.

Respectfully submitted,



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